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**To the International Preliminary  
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Torino, December 24, 2004

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Our Ref.: E-1950/03 LF

Dear Sirs,

**RE: International Patent Application No. PCT/EP 03/51022**  
**Applicant: UNIVERSITA' DI PISA et al.**  
**Examiner: G. Călămar.**

Reference is made to the First Written Opinion dated September 27, 2004 in connection with the above-referenced international application.

Please find herewith enclosed amended pages 3, 4, 4a of the description, as well as a new set of claims.

Claim 1 has been amended to include the following additional features:

a) the transmission unit (5) includes a transmission (7) having a drive element (10) connected angularly to the drive shaft (4) of the internal combustion engine (3) and a driven element (11) connectable to the propeller shaft (6); and

b) the clutch (8) is interposed between the driven element (11) of the transmission (7) and the propeller shaft (6).

Feature (a) was contained in original claim 2, although limited to the transmission (7) being a CVT and the drive and driven elements being respective pulleys of the CVT. This limitation has been eliminated on the grounds that original claim 1 did not contain any such limitation and that the use of a transmission other than a CVT is explicitly supported in the description (see page 12, lines 1, 2).

Feature (b) is implicitly, although not literally supported in the description and is clearly and unambiguously supported by the drawings.

Claim 2 corresponds - in essence - to the same claim as originally filed, since it includes the residual limitations not incorporated into claim 1.

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Claim 3 and each of the subsequent claims are unamended.

D1 discloses a hybrid drive unit including the features of the preamble of claim 1. However, the electric machine 2 of D1 is directly connected to the IC engine drive shaft and located upstream from (CVT) transmission 11; therefore, because of this arrangement, in the "regenerative brake mode" the drive unit of D1 allows energy to be recovered only through the CVT (as well as the other gearings such as planetary gearing 19), i.e. with a low efficiency.

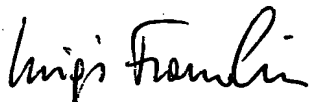
According to the present invention as claimed, the electric machine is located downstream from the transmission 7; the rotor of the electric machine is directly and permanently connected to the driven member of the clutch, i.e. to the propeller shaft.

Therefore, in the generative brake mode, there is a minimum efficiency loss.

On the grounds of the above amendments and arguments, we believe that the international application should now be in compliance with the PCT provisions and hope that a positive international preliminary examination report may be established.

Should however the examiner still deem that the international application is not in compliance with the PCT provisions, yet, he is kindly invited to issue a further written opinion or to contact us.

Yours faithfully,



Luigi Franzolin

Encl.

In the "parallel hybrid" configuration, both the combustion engine and the electric motor are connected to the drive wheels by appropriate transmission mechanisms.

Known hybrid drive assemblies of the type briefly  
5 described above are complex, expensive, and bulky, which is why, to the Applicant's knowledge, they have never been marketed for compact, low-cost vehicles, such as scooters.

EP-A-0 908 343 discloses a hybrid drive assembly  
10 including an internal combustion engine having a drive shaft, an electric machine having a rotor connected to a primary shaft aligned to the engine drive shaft, a clutch interposed between the engine drive shaft and the electric machine rotor, and a transmission unit including  
15 a CVT interposed between the primary shaft and the wheel axle.

Besides being considerably complex and thus not adapted for use in small road vehicles such as scooters, the above-referenced known hybrid drive assembly has a  
20 drawback in that the electric machine is located upstream from the transmission unit, and in particular the CVT, so that, when the electric machines operates as a generator (regenerative brake), energy recovery efficiency is reduced.

25 DISCLOSURE OF INVENTION

It is an object of the present invention to provide an extremely straightforward, low-cost, compact hybrid drive assembly, which can also be used in small, low-cost

road vehicles, such as scooters, but which also permits selection of a number of operating modes on the basis of different operating requirements or road conditions.

According to the present invention, there is  
5 provided a hybrid drive assembly for a vehicle having at least one drive wheel, the drive assembly comprising an internal combustion engine; and a transmission unit interposed between a drive shaft of the internal combustion engine and a propeller shaft connected  
10 angularly to the drive wheel, and in turn comprising a clutch and a transmission having a drive element connected angularly to the drive shaft of the internal combustion engine and a driven element connectable to said propeller shaft; the drive assembly further  
15 including an electric machine which can be operated instead of or in combination with said internal combustion engine, characterised in that said clutch is interposed between said driven element of said transmission and said propeller shaft, and has a drive  
20 member connectable to said driven element of said transmission and a driven member connected to the propeller shaft, said electric machine comprising a rotor connected angularly and permanently to said driven member of said clutch.

~~comprises a rotor connected angularly and permanently to said driven member of said clutch.~~

The present invention also relates to a vehicle, in particular a scooter, comprising such a hybrid drive assembly.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Two preferred, non-limiting embodiments of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a diagram of a hybrid drive assembly in accordance with a first embodiment of the invention;

Figure 2 shows a diagram of a control system for controlling the Figure 1 drive assembly;

Figure 3 shows a partial diagram of an alternative embodiment of the present invention.

#### BEST MODE FOR CARRYING OUT THE INVENTION

Number 1 in Figure 1 indicates as a whole a hybrid drive assembly for a scooter having a rear drive wheel 2 of axis A.

Drive assembly 1 comprises a combustion engine 3 having a drive shaft 4 of axis B parallel to axis A; and a transmission unit 5 interposed between drive shaft 4 and a propeller shaft 6 of axis C, parallel to axes A and B, and connected angularly to the drive wheel 2.

More specifically, transmission unit 5 comprises a continuously variable transmission or CVT 7 (hereinafter referred to simply as "CVT 7"), and a centrifugal clutch 8 in series with each other.

## CLAIMS

1) A hybrid drive assembly (1) for a vehicle having at least one drive wheel (2), the drive assembly comprising an internal combustion engine (3); and a transmission unit (5) interposed between a drive shaft (4) of the internal combustion engine (3) and a propeller shaft (6) connected angularly to the drive wheel (2), and in turn comprising a clutch (8) and a transmission (7) having a drive element (10) connected angularly to the drive shaft (4) of the internal combustion engine (3) and a driven element (11) connectable to said propeller shaft (6); the drive assembly (1) further including an electric machine (32) which can be operated instead of or in combination with said internal combustion engine (3), **characterised in that** said clutch (8) is interposed between said driven element (11) of said transmission and said propeller shaft (6), and has a drive member (20) connectable to said driven element (11) of said transmission (7) and a driven member (26) connected to the propeller shaft (6), said electric machine (32) comprising a rotor (35) connected angularly and permanently to said driven member (26) of said clutch (8).

2) A drive assembly as claimed in Claim 1, characterized in that said transmission (7) is a CVT, said drive element (10) and driven element (11) consisting of a drive pulley (10) and, respectively, a

driven pulley (11) of said CVT.

3) A drive assembly as claimed in Claim 1 or 2, characterized in that said clutch (8) is a centrifugal clutch; said driven member of said clutch (8) being a  
5 bell (26) integral with said propeller shaft (6).

4) A drive assembly as claimed in Claim 3, characterized in that said rotor (35) of said electric machine (32) is coaxial and integral with said bell (26) of said clutch (8).

10 5) A drive assembly as claimed in any one of the foregoing Claims, characterized in that said electric machine (32) is reversible.

6) A drive assembly as claimed in one of the foregoing Claims, characterized by comprising a coupling  
15 (51) interposed between said drive shaft (4) and said drive member (20) of said clutch (8).

7) A drive assembly as claimed in Claim 6, characterized in that said coupling (51) is controlled electromagnetically.

20 8) A drive assembly as claimed in Claim 6 or 7, when dependent on one of Claims 2 to 5, characterized in that said coupling (51) is interposed between said driven pulley (11) and said drive member (20) of said clutch (8).

25 9) A drive assembly as claimed in any one of the foregoing Claims, characterized by comprising an electric generator (37) driven by said internal combustion engine (3).

10) A drive assembly as claimed in any one of the foregoing Claims, characterized by comprising a control unit (38) for controlling said internal combustion engine (3) and said electric machine (32), in response to a number of input signals (Sa, Sf, Ss), in a number of operating modes comprising at least a combustion mode wherein only the internal combustion engine (3) is activated, an electric mode wherein said electric machine (32) operates as a motor and said internal combustion engine (3) is disabled, a parallel hybrid mode wherein said internal combustion engine (3) and said electric machine (32) are both activated and connected to said drive wheel (2), and a series hybrid mode wherein said internal combustion engine is disconnected from said drive wheel (2) and drives said electric generator (37).

11) A drive assembly as claimed in Claim 10, characterized by comprising selecting means (46) for selecting said operating modes of said drive assembly (1); said input signals (Sa, Sf, Ss) comprising at least a number of input signals (Ss) generated by said selecting means (46).

12) A drive assembly as claimed in Claim 10 or 11, characterized in that said input signals (Sa, Sf, Ss) comprise a signal (Sa) indicating the position of an accelerator member (44).

13) A drive assembly as claimed in one of Claims 10 to 12, characterized in that said input signals (Sa, Sf, Ss) comprise a signal indicating actions on a brake



control member (45) of the vehicle.

14) A vehicle having at least one drive wheel (2), characterized by comprising a hybrid drive assembly (1) as claimed in any one of the foregoing Claims.

5        15) A vehicle as claimed in Claimed 14, characterized by being a scooter.